DOCUMENT RESUME

ED 362 214 IR 016 370

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TITLE Evaluating the Impact of Technology at Peakview Elementary School.
PUB DATE Jan 93
NOTE 18p.; In: Proceedings of Selected Research and Development Presentations at the Convention of the Association for Educational Communications and Technology Sponsored by the Research and Theory Division (15th, New Orleans, Louisiana, January 13-17, 1993); see IR 016 300.
PUB TYPE Reports - Evaluative/Feasibility (142) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Comparative Analysis; *Computer Assisted Instruction; Computer Networks; Educational Change; Educational Innovation; Educational Objectives; *Educational Technology; Elementary Education; *Elementary Schools; Elementary School Students; Influences; Interviews; Job Satisfaction; Microcomputers; School Surveys; *Student Attitudes; *Teacher Attitudes; *Teaching Methods

ABSTRACT

Peakview Elementary School is a new elementary school that is implementing a number of organizational and teaching strategies advocated by the school restructuring reform movement. Among those strategies is the infusion of more than 80 networked microcomputers with their related technology and software. The impact of this technology on the school community was examined through a variety of data collection instruments, including classroom observation and surveys and interviews of 22 teachers and students at all grade levels. Survey data were collected in August 1991, when the school had just opened, and again in May 1992. Three other elementary schools were studied for comparison purposes. Consistent evidence was found that technology plays an essential role in facilitating the school's goals, with positive effects on student learning and attitudes. Students use the technology extensively for research and writing, as well as for instructional support in many subjects. Technology has changed the way teachers work, resulting in a net increase in the number of hours they work, coupled with greater productivity, effectiveness, and satisfaction. The implementation factors identified as contributing to the success of the school's use of technology form the basis of a set of recommendations for implementing technology in other schools. Four tables present study findings. (Contains 13 references.) (SLD)

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EVALUATING THE IMPACT OF TECHNOLOGY AT PEAKVIEW ELEMENTARY SCHOOL

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Clearly, something special is happening at Peakview Elementary School. Peakview is a new school that is implementing a number of organizational and teaching strategies advocated by the school restructuring reform movement. Among those strategies is the infusion of more than 80 networked microcomputers and related technology and software. This evaluation study examined the impact of the technology on the school community. Using a variety of data collection instruments (e.g., classroom observation, surveys and interviews of school personnel and students), we found consistent evidence that technology plays an essential role in facilitating the school's goals. The technology is positively affecting student learning and attitudes. Teachers are using the technology to adapt to individual students' needs and interests, and to increase the amount and quality of cooperative learning activities. Students use the technology extensively for research and writing activities, as well as for instructional support in a variety of subject areas. Technology has changed the way teachers work, both instructionally and professionally, resulting in a net increase of hours and at the same time greater productivity, effectiveness, and satisfaction. A number of implementation factors are identified as contributing to the success of Peakview's use of technology. These factors form the basis of a set of recommendations for implementing technology successfully in other schools. This paper is a brief summary of the project; more complete findings are reported in a "short report" (about 50 pages) and the full report (about 200 pages plus appendices.)

Peakview Elementary School opened its doors to students in the fall of 1991. From the outset, school staff intended Peakview to reflect concepts of school reform. Examples of innovative organizational strategies include multi-aging, teacher teams across grade levels, and a commitment to problem-solving and cooperative learning activities. A key component of the reforms was a greater role of technology to support classroom activities. A substantial investment in computer and video resources was made, resulting in more than 80 Macintosh computers available in the school, most of them distributed in the classrooms. Classrooms presently house an average of 4–6 color Macintosh computers each. This is a significant increase in the quantity and quality of computers typically available in elementary school classrooms. Technology products—including optical laserdiscs and computer-based instruction—have replaced science, social studies, and math textbooks.

Most of the reforms implemented by Peakview staff are structural in nature and do not require significant additional resources. The increased reliance on technology for instruction, however, constitutes a more costly reform. In spite of redirecting monies normally allocated towards textbook purchases, the net cost to the school is substantial. A question posed by school staff is:

- Is it worth it? Does the technology support the innovative structures and goals of the school?

A parallel question relevant to district decisionmakers is:

- Would the Peakview use of technology be a model worth disseminating to other elementary schools in the district?

These are questions of worth, implying a tradeoff between costs and benefits. Although the present study is not a formal cost/benefits study, the questions above are still pertinent. ***Our purpose in conducting the study was to evaluate the impact of technology on the school.*** Of particular importance is the role of technology in furthering the school reform initiatives being undertaken. That is, ***does the use of technology impede, afford, or even accelerate the effectiveness of the teaching approach being implemented at Peakview?*** The findings of the study will evaluate the overall worth of the technology within the system; decisionmakers within the school and district should then be able to determine whether the added costs involved provide a justifiable return on investment.

The Study's Design

This is primarily a case study of Peakview Elementary School and its use of technology. A number of data-collection instruments were used to help provide valuable information concerning the school; these are discussed in the Method section below. The study relied heavily on written surveys and interviews of teachers and students.

The present study was designed and conducted to be a sort of "snapshot" of conditions at Peakview. To provide a context for understanding, comparison were made of two kinds:

Beginning vs. end of school year. Survey data were collected at two different times: August 1991—one month after Peakview's opening—and May 1992, toward the end of the school year. This allows some perspective on changes over the course of the school year.

Peakview versus other schools. To gauge in what respects Peakview differed from other schools in the district, three additional elementary schools were selected for comparison. Two schools were selected primarily for logistical convenience: Summit and Polton had staff members who were students within UCD's Division of Instructional Technology. These staff members agreed to collaborate with us in conducting the research. Summit has a computer lab of Apple IIgs computers, and very few computers in individual classrooms. Polton also has a lab, with a few computers in classrooms. Parallel survey data were collected at these additional elementary schools; no other data were collected from these schools. Dry Creek was selected because it was perceived to be similar to Peakview in that computers were integrated into classrooms, but different because the computers were Apple II's rather than Macintosh computers.

Shifts in Teaching Methods

Collins (1991), a noted cognitive psychologist, cited eight trends in changing teaching methods. These changes are supported by research in cognitive psychology. Collins notes that each of these changes in teaching method can be facilitated by technology. We have listed each trend below along with a brief comment relating the teaching method to technology.

1. ***A shift from whole-class to small-group instruction.*** Gearhart, Herman, Baker, Whittaker, and Novak (in press) observed a dramatic decrease in teacher-led activities when computers are used, from 70% to less than 10%.

Traditional Teaching Methods	Technology-Assisted Methods
Whole-class instruction	Small-group instruction
Lecture and recitation	Coaching
Working with better students	Working with weaker students
Less engaged students	More engaged students
Assessment based on test performance	Assessment based on products, progress, and effort
Competitive social structure	Cooperative social structure
All students learning the same things	Different students learning different things
Primary of verbal thinking	Integration of visual and verbal thinking

Table 1. *Trends toward constructivist teaching methods facilitated by technology (Collins, 1991).*

2. ***A shift from lecture and recitation to coaching.*** Again, Gearhart and colleagues (in press) found an increase in teachers serving as facilitators (rather than directors of behavior) when using computers, from 20% to 50% of class time. Collins (1991) comments: "The introduction of a third party, the computer, into the situation encourages the teacher to play the role of a coach, in much the same way that a piano encourages the teacher to play the role of a coach in a piano lesson" (p. 29). Schofield and Verban (1988a) found teachers using first-person constructions ("Let's try this") over second-person, didactic constructs ("You should do this") when using computers.
3. ***A shift from working with better students to working with weaker students.*** In traditional classrooms, teachers often carry on a conversation with brighter students who raise their hand; teachers often ignore slower students to avoid embarrassing them. With technology, that pattern is reversed: Schofield and Verban (1988a) found slower students receiving two to four times more attention from the teacher.
4. ***A shift toward more engaged students.*** A number of studies have demonstrated that students who work with computers exhibit greater task engagement, often to the point of fighting over computer between classes and after school. "To the degree that the computer supports long-term effort rather than short exercises...students become invested in the activities they carry out on computer" (Collins, 1991, p. 30).
5. ***A shift from assessment based on test performance to assessment based on products, progress, and effort.*** Teachers have traditionally relied on end-of-unit tests for assessment. Technology shifts assessment efforts from tests to effort and progress on projects, and on the final product. This, of course, poses new problems for teachers as they search for meaningful and reliable ways of evaluating work products.

6. ***A shift from a competitive to a cooperative social structure.*** A number of researchers have noted greater cooperation among students when using technology. For example, Harel (1990) studied 4th graders as they developed their own lessons to teach fractions to 3rd graders. She found students naturally sharing ideas and helping each other solve problems in their programming.
7. ***A shift from all students learning the same things to different students learning different things.*** A number of studies have shown how technology can support students as they tackle various parts of a complex project, each contributing to a larger final product. What this means is that students are working on separate aspects of a problem. Students working on different learning goals can be a logistical nightmare without technology to maintain focus and manage information.
8. ***A shift from the primacy of verbal thinking to the integration of visual and verbal thinking.*** Visual media—television, film, and computers—have begun to gain parity with abstract text as a primary means of learning in our day. Lectures, multiple-choice tests, and recitation of knowledge become less relevant methods when faced with technology-based alternatives.

In other words, society in general and education in particular are coming to value a certain approach to education. There is some evidence that technology can help education practice move in those valued directions. This line of thinking influence the design of the present study; the reasoning was: Technology can be justified to the degree that its use is found to facilitate instructional methods and learning goals that are valued by the school and/or the district.

METHOD

In consultation with Peakview and Cherry Creek leadership, we developed a list of research questions to be addressed by the study. These questions then drove the development of data-collection instruments, and provided a structure for reporting findings. The questions were based on:

- the stated goals and objectives of the school;
- the expressed need of school and district staff;
- the expected impact based on the review of literature.

Instruments

The lengthy list of evaluation questions suggests that a variety of data-collection methods be used; hence, a number of instruments for data collection were developed and used. The major data collection instruments are listed below.

August 1991	Baseline survey.
May 1992	Main survey (administered at Peakview and 3 comparison schools) • Primary student surveys. • Intermediate student surveys. • Teacher surveys. • Staff surveys.
May 1992	Peakview teacher/staff interviews.
May 1992	Peakview student interviews.
May 1992	Peakview teacher logs and written reports.

Depending on the data source, a number of different strategies for interpreting the data were used. For surveys, bar charts were developed to display the means and distributions of responses to questions; responses were separated according to school, with Peakview separated from the remaining schools to allow clear comparisons. These bar charts allow a visual comparison of the response patterns between Peakview and the comparison schools. Line charts were also developed comparing the mean responses of the four schools. Where possible, chi square (χ^2) or analysis of variance (F statistic) were calculated to compare responses across schools.

Responses to open-ended questions from the survey and interview questions were treated similarly. Data were coded into qualitative categories; these categories were then used for reference and retrieval. In addition, where appropriate counts were conducted on the frequency of different response categories; the frequency breakdowns of these counts are presented in the findings.

SELECTED FINDINGS

This section reports the findings of the study in highly abbreviated form. Graphs and tables comparing Peakview with comparisons schools are presented in the full report.

Use of Technology

Prior to coming to Peakview, teachers showed a typical range of prior experience in using technology. In August 1991, Peakview teachers most commonly reported "sometimes" to the statements:

> I have used computers before with children in my classroom.
> I have used computers before with children in school (computer lab, etc.).

Since coming to Peakview, teachers find themselves using technology daily in their classrooms. Peakview students spend roughly twice the time on technology as a students in comparison schools. Teachers keeping a weekly log reported spending 39% of students' worktime spend using technology. Peakview students confirm this report of greater technology use. Peakview elementary students report using computers several times a week, whereas comparison students average about once or twice a week. Primary students report similar usage patterns.

Comparison to teachers at comparison schools, Peakview teachers report significantly more use of technology in all major areas:

- word processing ($p < .001$),
- authoring, ($p < .06$),
- art and graphic activities ($p < .001$),
- instructional software ($p < .01$), and
- laserdisc viewing ($p < .001$).

Teachers report greater use of alterantive media, greater use multiple modalities. Student self-report data corrobate this finding. Contrary to sales pitches, teachers report working longer hours as a result of the technology. On the other hand, many teachers report having more time for small-group and individualized activities.

The technology available at Peakview affects the kinds of instructional strategies teachers use in the classroom. Peakview teachers overwhelming agree that technology makes their teaching more effective. Consistent with Collins' (1991) analysis of trends in education, we found that technology enables teachers to succeed in areas that are important to them, summarized in Table 2 below.

Learning Goal	Importance to Teachers	Effect of Classroom Technology	Peakview versus Other Schools
Accommodate different learning styles	Very high priority	Moderate to heavy	Peakview higher ($p < .001$)
Self-directed learning	Top priority	Heavy	Peakview higher ($p < .001$)
Accommodate students working on multiple learning goals	Top priority	Moderate to heavy	Peakview higher ($p < .001$)
Students teaching themselves and others	Very high priority	Moderate to heavy	Peakview higher ($p < .01$)
Student research skills and independent access of information	High priority	Moderate to heavy	Peakview higher ($p < .01$)

Table 2. *Teacher priorities of different learning goals, and how technology impacts on those learning goals.*

Peakview teachers report that technology affects other desirable educational goals and strategies, including:

- cooperative learning activities (whereas non-Peakview teachers reported very little effect of technology on cooperative learning);
- productive time on task;
- student attentiveness.

Teacher attitudes

At the beginning of the 19992 school year, a survey asked Peakview teachers to contrast their prior conceptions to present conceptions toward technology:

[I used to]... watch.
[Now I]... try.

[I used to]... look for the "expert" to help kids who were stuck. .
[Now I]... try things out for myself -and by doing it daily several times, I'm learning some procedures by heart!

[I used to] ... see the potential of computers for other people
[Now I]... see the potential for myself!

[I used to]... *avoid computer at all cost.*
[Now I] ... *only avoid them during Bronco games.*

These responses clearly indicate a shift toward more receptive, positive attitudes toward technology. Later in May, 20 of 21 responding teachers at Peakview reported that their attitudes toward technology in the classroom have changed substantially over the past year. Teacher interviews yielded the same finding:

I may have been a little skeptical, at first, but I am a true believer in the vital role computers have in our educational system! Nora, Kindergarten teacher

My goal is to learn more! I'm getting over a lot of my "fears" about computers, but there's an awful lot I still need to learn! I feel a comfort level settling in, but I need more information!!! More time to learn!!! Nora, Kindergarten teacher

What I will always remember about this year is the realization that teachers need not be computer wizards...just learners. Matt, intermediate teacher

Peakview teachers report higher "comfort levels" than their counterparts in using word processing, videodisc viewing, and arts and graphics programs. With some exceptions, teachers at all four schools reported relatively low comfort levels using databases, spreadsheets, and programming. Peakview students received more encouragement from their teachers in using technology, and said their teachers seemed to enjoy using the technology. Virtually all of the data we collected in the study served to corroborate the finding of positive teacher attitudes at Peakview.

Student Achievement

Eighteen of 22 Peakview teachers agreed that student achievement is increased when they use technology. The remaining four were undecided; none disagreed with the statement. From teacher interviews:

I think they are excited about learning. It's a new avenue...they are doing writing, [and] reading things I didn't think first- and second- graders could do. It's interesting...I have kids who are working on projects [and] units...the learning is more in depth...more opportunities, not just a book and paper. Charlotte, primary teacher

Supermunchers—the kids taught themselves new words so they'd be able to do it. They really have made themselves learn the new words. Ginny, primary teacher

Achievement gains in reading and writing are very pronounced, especially with kids on the low end. Adam, intermediate teacher

I've never had a class that has known all the letters. This year every child in my class knows every letter of the alphabet. A lot of it is due to the computer. I can't say exactly, but I feel certain that it is. Mary, Kindergarten teacher

Technology is a good way to:	Peakview Teachers	Non-Peakview Teachers	School Differences
Learn basic skills	Agree to Strongly Agree	Agree	ns
Help students learn to work in small groups.	Agree to Strongly Agree	Agree	ns
Access and use information	Strongly Agree	Agree to Strongly Agree	ns
Learn oral and written communication skills	Agree	Undecided	Peakview higher ($p < .05$)
Help students learn to research and report on a topic	Strongly Agree	Strongly Agree to Agree	ns
Learn problem-solving skills	Agree	Agree	ns

Table 3. *Teachers as a way to teach different learning outcomes.*

Student Attitudes

Attitudes toward school. Peakview students generally like school, with a majority responding that school is not too easy and not too hard, but rather "just right." They say technology makes school "a lot" more fun. Peakview students report liking school "a lot more" because of the technology. Non-Peakview intermediate students differ markedly ($p < .001$), with responses averaging "a little more."

Attitudes toward technology. Peakview students were asked in the August Baseline Survey several questions aimed at gauging their feelings toward the technology available at the school. Intermediate students generally agreed about the important of learning to use computer, about their parents' endorsing their learning, and that technology was a good way to learning something new.

Intermediate students at all four schools uniformly reported wanting to learn more about technology, with Peakview students showing markedly greater enthusiasm ($p<.001$). Primary students in focus interviews at all four schools unanimously agreed with the same statement. Students at the four schools also concurred that learning about technology was an important goal. Again, Peakview intermediate students showed a stronger conviction than non-Peakview students ($p<.05$).

Students across the four schools reported a preference for technology-based learning over textbook-based learning. Peakview intermediate students expressed stronger agreement than non-Peakview students ($p<.05$). This confirms intermediate student reports in the August Baseline Survey.

Teachers confirmed positive student attitudes regarding technology.

> *They love the computers! For Free Choice Center, I always have to say "Who wants to go to the computers first?" It's the most favored thing that they like to do.*

They love the technology. They have a kind of 'I can' attitude.

Students spoke for themselves about their attitudes toward the technology:

Technology is really a outstanding thing. I hope I am good in technology. We didn't use computers much in our old school. Some of the people in our class are really good typers on the computer. I really like my school. I'm glad we have a lot of computers. Brittany

I used to write and write. But I never had any pleasure with it. I would cherish the times I got to go to the computer lab. I never dreamed of using as cool technology as I do now. Anne

I love technology and praise this school for preparing me for tomorrow's society. I am very scared about tomorrow, but I am prepared and confident in my peers. I wish to have a future part in the technology market. I also think that future school should have this privilege. Kevin

Attitudes toward learning. Peakview students were asked in the August Baseline Survey questions related to technology and learning. Students at all grade levels report agreement that technology will help them learn. Peakview teachers observed that students are highly motivated to stay on task and learn with technology:

The kids are affected. Can I stay in recess, can I stay late? We have such a short recess period, I wish we had more opportunities to do more. Michael, intermediate teacher

...98% of the kids will choose to stay in and work with computers rather than go outside for recess . Nora, Kindergarten teacher

Kids come early, stay late, stay in at recess. Brad, Kindergarten teacher

Students commented:

I like computers a lot and I do as much as I can on computers. We've got a computer at home. It's a quicker way to do things. It's fun and it's good to learn with. Charles Johnson

If we didn't have technology everyone would be bored...there'd be nothing to do. Mathew

Attitudes toward self. When asked if technology makes them feel good about themselves, Peakview intermediate students agreed more strongly than non-Peakview students ($p<.001$). Primary students at all four schools also reported that using technology makes them feel good about themselves. Most (83%) report computers being "easy."

Interviews of Peakview intermediate students illustrate the positive effects technology can have on some children's self-concepts:

Technology has really been a very good experience for me this year. I've been getting better grades, in which I've been excepted into the G.T. program and I think it's do to the technology because you can learn stuff with technology like laserdiscs, G.T.V., and CD-ROM. I will be going to Thunder Ridge next year and hope I'll have at least on class (not counting computer class) that has at least 6 computers in it like Peakview. I've done some projects without technology and some with it, and it was much easier with the technology. Charlotte

My feeling about technology are...that since so many computers are at Peakview I seem smarter. The computers are like electronic textbooks Except they are tons more fun.. Elizabeth

Intermediate Peakview students, asked in August if they were worried about making mistakes on the computer, responded diversely. The fact that so many students reported concerns about errors suggests that, even for children who view computers as easy and view themselves as good at computers, making mistakes can still be a concern.

A survey response by a fourth grader further illustrates how many children feel about the technology at Peakview:

I used to not be alod to use technology that mach at all. I felt relly dome when I was at my old school. But now I think technology is grand but in a way it is hard. So well I stell love technology and howe it work's. Heather

In summary, students' self-concepts are affected by a number of factors. Trying to isolated the effects of technology is difficult. The great majority of students view technology as easy, particularly Peakview students. However, a number of Peakview students, at the beginning of the year, reported worrying about doing something wrong on the computer. It seems that there may be some students with concerns about the technology and their confidence in using it. On the positive side, students at all four schools generally agreed that technology make them feel good about themselves. Eighty-six percent of Peakview intermediate students agreed the statement. This indicates a strong number of students whose self-concepts are likely helped by through working with technology.

Student empowerment. An important educational goal is to help children come to feel in control of their own learning. Taking charge of one's learning—independent of the teacher's behavior and the school environment—is often not entirely achieved until high school. Because technology-based activities can often take the form of independent or cooperative research activities, we were interested in gathering information on this question.

Intermediate students across the four schools generally agreed with the statement, *I like technology because the teacher doesn't always have to help me* . Primary students showed a similar profile of agreement to the statement. Students generally agreed with the statement *I like to make my own choices about how I use the technology,* although a number of students were "unable to judge." Primary students at the four schools concurred. Responses were similar to the question, *I like to think of my own ways to use technology.*

Attitudes of children with special needs. The motivation and attitudes of certain children are especially important when considering educational innovations. For example, if most children had positive attitudes toward a new strategy, but low-achieving children hated it, that finding would be cause for concern, even if the strategy were generally beneficial. Teachers were asked specifically about technology's potential in enhancing the self-esteem of at-risk students. Staff members at all four schools agreed that technology can enhance the self-esteem of these children; Peakview staff members strongly agreed with the statement.

Students limited physically seem also to be helped by the technology. One advantage is in the ease in interacting with the keyboard for students who have difficulty controlling their fine motor movements. A Peakview special education teacher commented:

Technology has changed my life and the lives of my students, almost entirely with positive changes. First of all, most of "my" kids have difficulty with reading and writing, and they are much more motivated by such avenues as computers and laserdiscs to read and write. In writing, for example, students can pull up a variety of pictures for inspiration on the computer, then enjoy the increase of their keyboarding skills and their professional production as they write their stories. For students with fine motor difficulties, who find it hard to produce legible writing the computer opens a whole new avenue of flexible expression. Gerri, K–5 special education teacher

Perhaps what I've noticed the most is the success and growth it gives children when they might not be receiving it from other academic areas. Having a special needs child in my classroom is proof of that. It is through the computer that he is able to choose spelling words, read and follow a book on the CD-ROM and most importantly be able to communicate through a keyboard using pictures and sound. I know that as he continues to use technology he will become more proficient, meaning he will become a better communicator with those around him. Charlotte, primary teacher

One teacher commented on lower-achieving students and the help technology can be:

I have seen "non-readers" become avid consumers of written information. I have seen "non writers", especially those hampered by poor fine motor skills, show tremendous pride in their obvious growth as writers. Kids who, eight months ago, would have run at the mention of research projects, now actively pursue areas of interest ranging from American political figures to zoology.

Summary of the Findings

The table below outlines the various effects we have found at Peakview Elementary. The table does not include the strength of evidence for the various findings, but it does provide a handy overview of the various factors affected by technology at the school. Although the study identified a number of areas that need refinement, we could not identify a general impact area where the technology was perceived to have a negative impact.

Impact of Technology On:	Strongly Positive	Positive
Use of Technology	X	
Use of multiple modalities	X	
Use of media	X	
Impact on Teaching		
Accommodating ability levels	X	
Small group instruction		X
Competitive vs cooperative social structures		X
Verbal and visual learning media		X
Time on technology	X	
Time on task	X	
Self-directed learning	X	
Accommodating multiple learning goals	X	
Accommodating learning styles		X
Students as teachers	X	
Information access and research activities	X	
Changes in teacher work	X	
Teacher attitudes		X
Teacher comfort levels		X
Computer coordinator	X	
Taking computers home	X	
Computer as a stimulus to change		X
Teacher perceptions of students		X
Self-concepts as competent professionals		X
Student achievement		X
Attainment of basic skills		X
Access and use of information	X	
Problem-solving skills		X
Oral and written communication skills		X
Researching and reporting	X	
Student's perspective		X
Small-group work		X
Other forms of achievement	X	
Student attitudes	X	
Towards school	X	
Towards technology	X	
Towards learning	X	
Towards teachers	X	
Towards self	X	
Student empowerment	X	
Special needs students	X	

Table 4. *Summary of the impact of technology at Peakview Elementary School.*

Conclusions of the Study

1. ***Students and teachers are using the technology.*** The available evidence suggests that the technology is being used heavily at Peakview Elementary. Generally, the kind of use includes word processing, graphics, instructional software, and laserdisc viewing. Students use technology in finding information, researching and writing about topics, and in problem-solving activities.
2. ***Technology is changing classroom practice.*** Peakview teachers overwhelmingly prefer 4–6 computers in the classroom over computer labs. Technology has stimulated innovation in the way subjects are taught; several teachers report adapting their teaching to better integrate technology into different subjects. Other teachers report a desire to continue learning more about the technology, in order to continue changing their classroom practices. Teachers report working more hours because of the technology, and having more control over their work.
3. ***The technology has changed teachers' beliefs and attitudes.*** Peakview teachers underwent an attitude shift in their first year using technology at Peakview. They came to see technology as a powerful tool to facilitate learning in elementary children. They believe that technology can be a vehicle for accomplishing many of the learning and instructional goals that are important to them, such as problem-solving skill, cooperative learning, independent research skills, and individualization according to learners' needs. They have gained confidence in their own abilities to use computers and other technologies.
4. ***Students learn effectively using the technology.*** Students are showing tentative learning gains in a variety of areas. Their skill at using technology is obviously improved. Some teachers report reading and vocabulary improvements in early grades. Students do more editing and revising of written work using word-processing tools. Spell checkers are only sparingly used by students. A number of intermediate students are using the technology for a variety of independent or small-group projects, including:
   - Combining paint graphics and word processing;
   - Incorporating scanned and clip-art graphics;
   - Authoring HyperCard projects;
   - Using CD-ROM and optical laserdisc information references;
   - Incorporated CD-ROM and laserdisc sequences into HyperCard projects.

   Teachers and students report greater student interest and initiative in completing research projects.

5. ***Students are motivated to learn with the technology.*** Students experience increased independence and empowerment as a result of the way technology is used. Teachers report that students work more productively with computers. Student attitudes are positively affected by technology, toward:
   - school,
   - technology,
   - learning, and
   - themselves.
6. ***Technology is a vehicle for many of the school's reform initiatives.*** Multiaging (having children K–3 in the same classroom) becomes more manageable when technology is used.
   - Process instruction in writing is feasible when editing and revisions can be done on computer.

- Independent research can be more easily accomplished when electronic forms of references are consulted, and when student data is stored and manipulated on computers.
- Technology-related projects lend themselves well to cooperative learning groups. Students can collect projects into electronic portfolios, allowing for alternative, authentic assessments of their learning.

Each of these initiatives is part of Peakview's innovative philosophy of elementary education. There is no question that without the technology, many of these practices would go forward. However, access to the technology improves the likelihood that these reforms will succeed.

7. Key elements of ***successful implementation*** include:
   - ***Computers abundantly available in the classroom.*** Each classroom houses 4–6 color Macintosh computers; computers are often shared between adjoining classrooms to allow more flexible use of resources. According to teachers, the number of computers in the classroom, and teachers' and students' easy access to them, is a powerful factor contributing to successful implementation.
   - ***Shared commitment and vision of school reform with technology as an essential component.*** The amount of work required to successfully begin a school with a number of innovations should not be underestimated. The Peakview community—particularly the teachers and administration—articulated a vision for the school, and they committed to making that vision happen. The entire staff bought in to the program, and worked had to overcome the many obstacles and challenges encountered along the way. An atmosphere was cultivated that encouraged offering mutual support and sharing resources.
   - ***A supportive district and principal.*** Peakview received the support of district administration in developing an innovative set of values and methods for elementary education. The principal supported the use of technology at the school, and enthusiastically learned to use the Macintosh along with the rest of the staff. The leadership and commitment of district- and building-level administrators created conditions conducive to success at the school.
   - ***A strong computer coordinator.*** Peakview has one teacher assigned full-time to technology leadership and support. This position seems to be a critical component of the school's implementation of technology. The computer coordinator seems to give other teacher the courage to "charge ahead" in the use of the technology. Hardware and software systems are maintained and managed; inservices are provided to staff and students; troubleshooting help is provided for problems as they arise.
   - ***Early and thorough teacher training.*** Before the school opened, teachers received training on Macintosh operating system, *Microsoft Works*, and instructional software to be used in classes. Inservice lessons have been regularly made available to teachers and students. This access to expertise seems to have been very helpful to teachers.
   - ***Taking computers home.*** Following initial training in the spring of 1991, each teacher was given a computer to take home for 6 weeks. According to many teachers, this allowed them time to become comfortable with the technology before school started. Many teachers reported receiving tutorial help from their children.
   - ***User-friendly systems.*** The color Macintosh LCs at the school have contributed to the attitude change among many teachers. High-quality software is another factor in the school's successful implementation.

Recommendations to the School

1. Continue inservice training, particularly informal lessons with teachers and students attending together.
2. Train teachers in uses of database, spreadsheet programs, and other tools.
3. Continue computer coordinator position.
4. Periodically perform a self-study to assess progress, set priorities, spot trends, and establish strategic goals and plans.
5. Build regular maintenance and upgrade costs into regular school budget.
6. Continue developing electronic portfolios and other authentic assessment methods.
7. Develop improved assessment measures to track performance gains over a period of years.
8. Continue to develop electronic-mail (e-mail) and telecommunications capabilities.
9. Continue to cultivate parental involvement.
10. Find more problem-solving software, particularly in science.
11. Carefully implement cooperative learning activities, ensuring equitable workload among students and efficient use of time.

Recommendations to the District

1. Use Peakview as a model for other elementary schools in the district.
2. Perform a cost/benefits analysis to determine:
   - if Peakview technology-related outcomes are highly valued;
   - if the value of those outcomes justify the additional cost of the technology.
3. Incorporate objective measures of Peakview's performance into the data provided by the present study.
4. Measure student competencies throughout the district.
5. Continue to support Peakview as a prototype lab to try out new technologies and methods.

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